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# Lifetime impact of SO<sub>2</sub>-poisoning of a Cu-CHA catalyst for NH<sub>3</sub>-SCR

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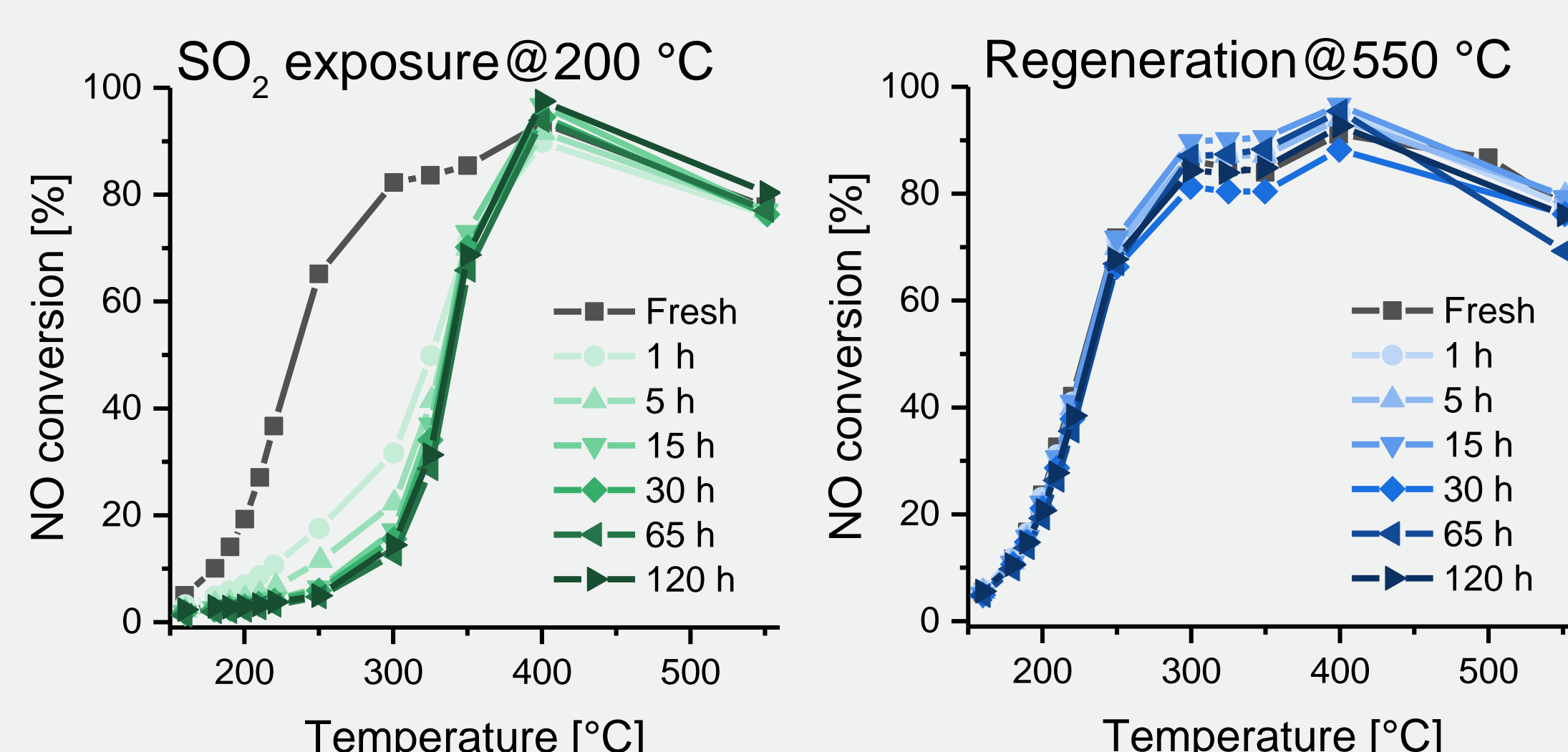
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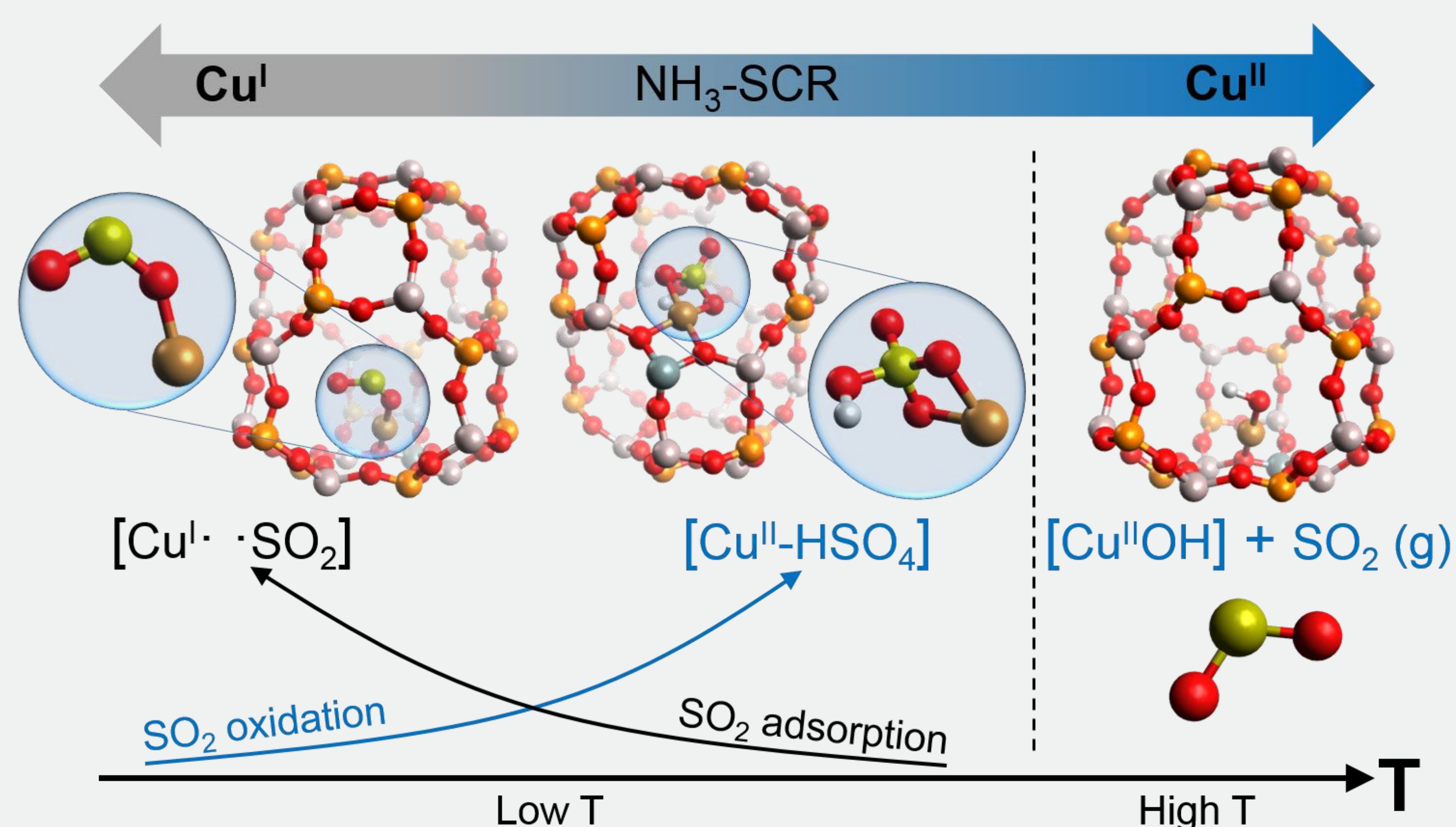
## Background

The highest activity for removal of NO<sub>x</sub> (NO and NO<sub>2</sub>) in the temperature range 180-250 °C, by selective catalytic reduction (SCR) with NH<sub>3</sub> in the after treatment system of heavy-duty vehicles, is obtained with Cu-zeolite catalysts. Improved fuel efficiency that is necessary for lower CO<sub>2</sub> emissions, has led to colder exhausts, which has increased the importance of efficient NO<sub>x</sub> removal in that temperature range. However, Cu-zeolites deactivate by the inevitable presence of SO<sub>2</sub> in diesel exhaust, and therefore, we have investigated if the lifetime impact of SO<sub>2</sub> on the activity of a Cu-CHA zeolite catalyst is prohibitive for practical application.



## Typical SO<sub>2</sub>-poisoning behavior

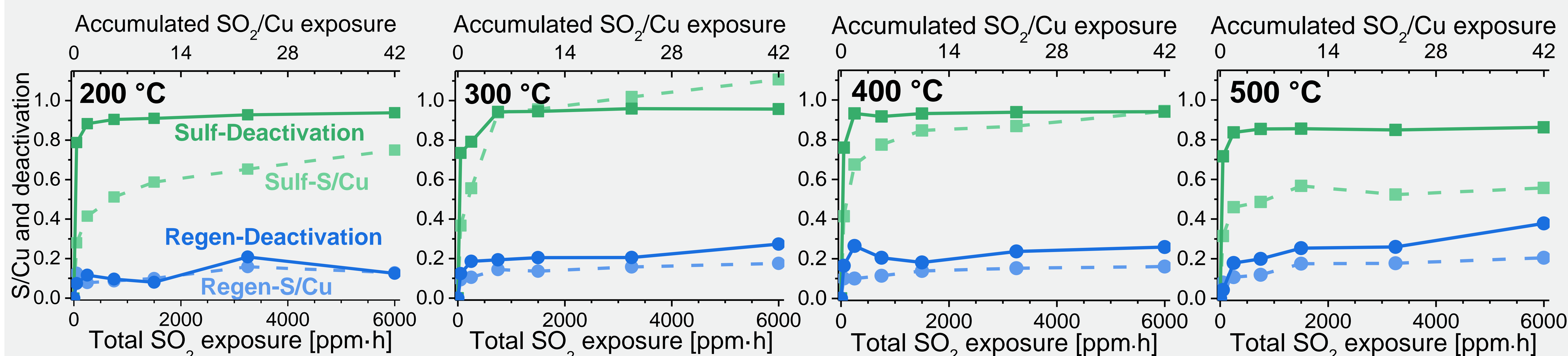
- Exposure to SO<sub>2</sub> results in significantly lower NO conversions in the temperature range 180-350 °C
- Regeneration at 550 °C in SO<sub>2</sub>-free gas can restore the predominant part of the drop in NO conversion inferred by SO<sub>2</sub>



## Potential lifetime SO<sub>2</sub>/Cu exposure

Assumptions for the lifetime of a heavy-duty vehicle:

- Distance: 800 000 km
- Average mileage: 30 L diesel/ 100 km
- Diesel: 5 wt ppm S (Ultra-low sulfur diesel in: EU: <10 wt ppm S, USA: <15 wt ppm S)
- Cu-CHA: 1.5 kg with 3 wt% Cu (45 g Cu)
- Potential accumulated lifetime SO<sub>2</sub>/Cu exposure: **44**



## Experimental

**Catalyst:** Cu-CHA powder with Si/Al of 14.6 and Cu/Al of 0.42 (2.76 wt% Cu on dry matter basis), and of sieve fraction 150-300 µm.

**SCR activity measurements:** 5 mg catalyst, 500 ppmv NO, 533 ppmv NH<sub>3</sub>, 10 % O<sub>2</sub>, 5 % H<sub>2</sub>O, with N<sub>2</sub> at a total flow rate of 225 NmL/min.

**SO<sub>2</sub> exposure:** 50 ppmv SO<sub>2</sub>, 10 % O<sub>2</sub> and 5 % H<sub>2</sub>O with N<sub>2</sub> to 1.67 NL/min at 200, 300, 400 or 500 °C for 1, 5, 15, 30, 65 or 120 h.

**Regeneration:** 6 h at 550 °C in 10 % O<sub>2</sub> and 5 % H<sub>2</sub>O gas.

**ICP-OES:** S/Cu ratios of the sulfated and regenerated catalysts.

## Conclusions

- Deactivation occurs fast regardless of exposure temperature
  - Maximum deactivation levels reached already at low S/Cu ratios
- Regeneration at 550 °C can limit deactivation to 20 % throughout the catalyst lifetime
- Practical application of Cu-CHA as SCR catalyst is contingent on:
  - Efficient regeneration
  - Use of ultra-low sulfur diesel